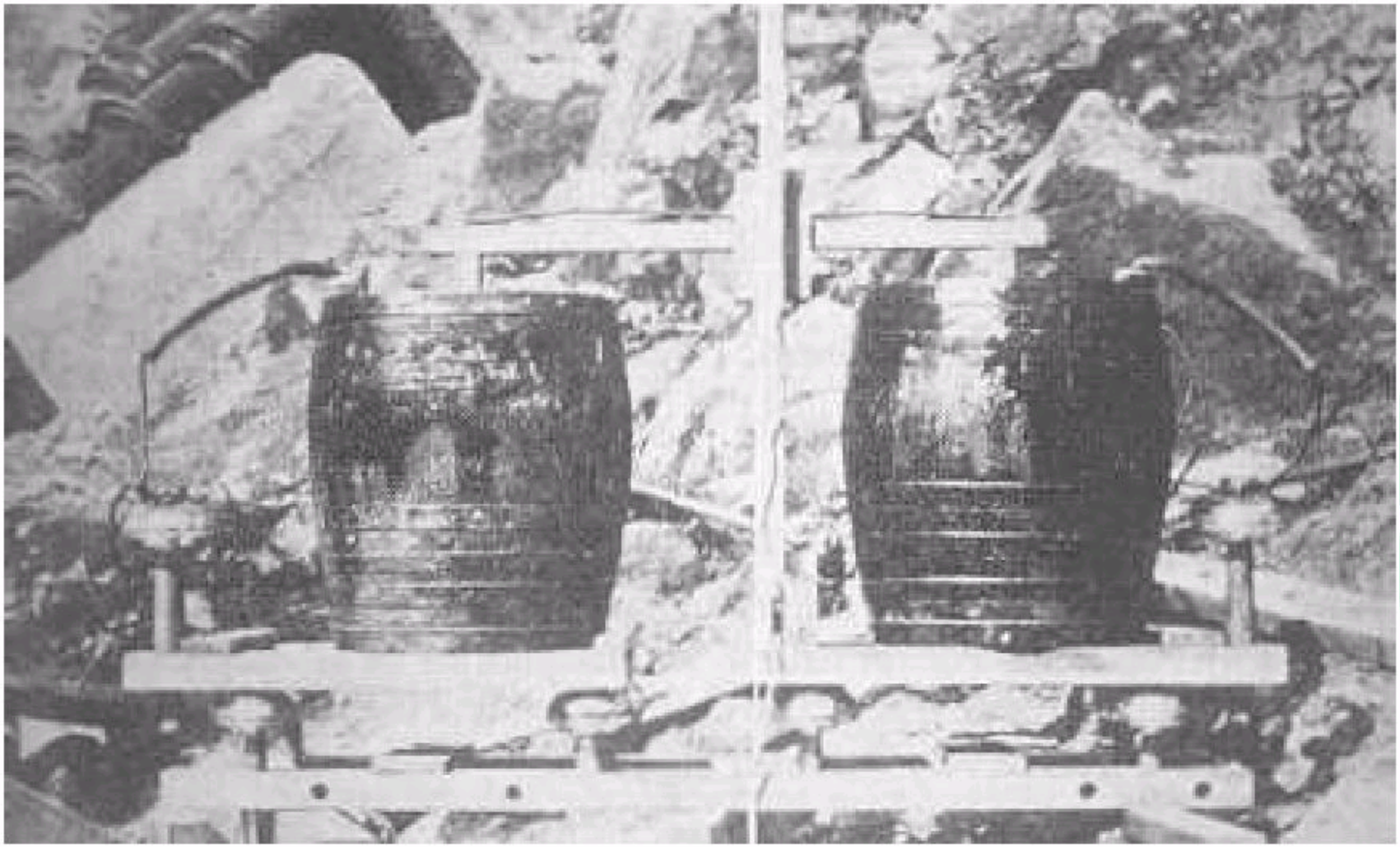
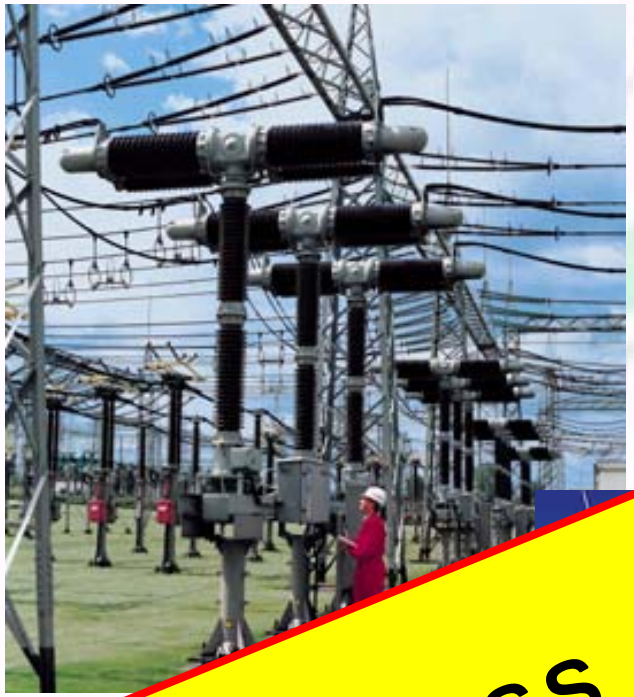
CIGRE WG A3.06

Reliability of High Voltage Equipment

Preliminary Results Circuit Breakers

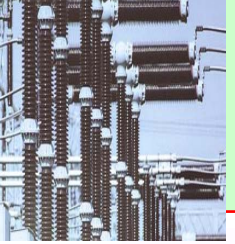


„First“ High Voltage Circuit Breaker 1847



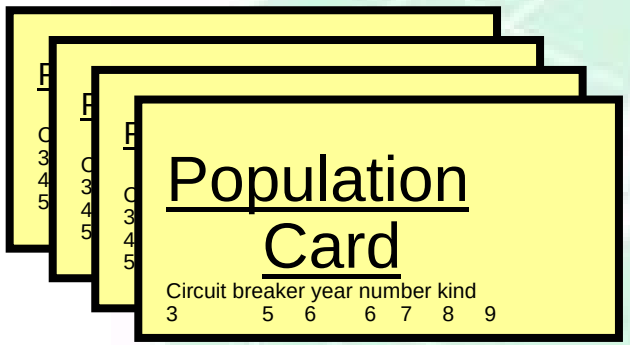
Progess regarding Reliability ?

High Voltage Circuit Breakers / Modern Design



CIRCUIT BREAKERS

2004 : 3rd survey on CB reliability



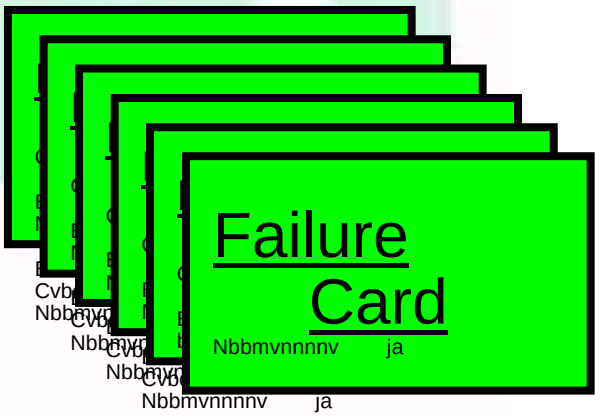
Population data

1 x per year

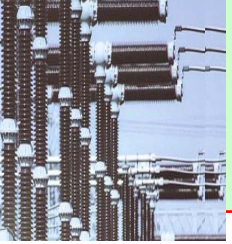
Failure data

1 x per event

- major
- minor



Only SF6 single pressure technology !



CIGRE WG A3.06 Reliability of High Voltage Equipment

Preliminary results CIRCUIT BREAKERS

Old Survey 1988-91

70.708 CB years

Survey lasts 4years:

17.677 CB / year

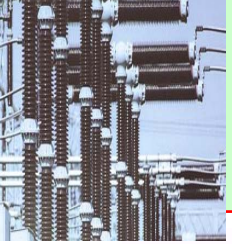
22 countries

Population data

New Survey

41.959 CB / **2004**

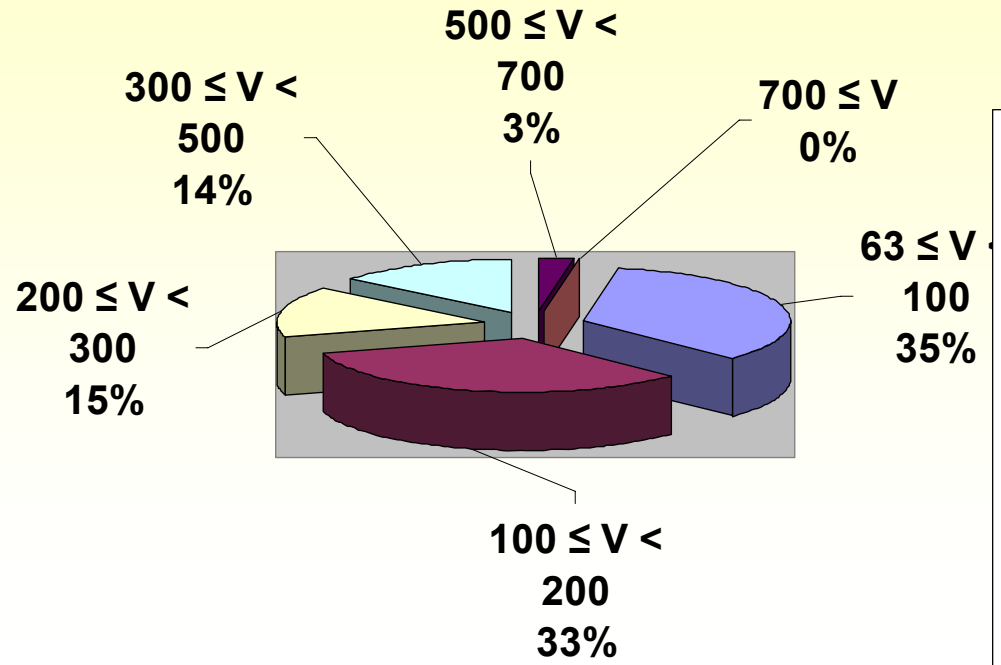
21 countries



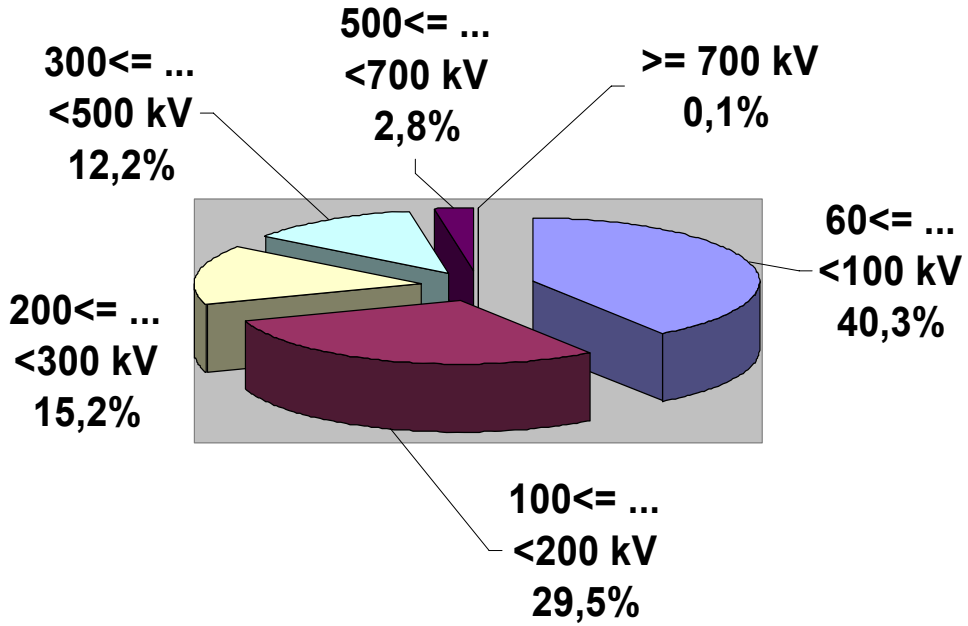
CIGRE WG A3.06 Reliability of High Voltage Equipment
Preliminary results
CIRCUIT BREAKERS

Population data

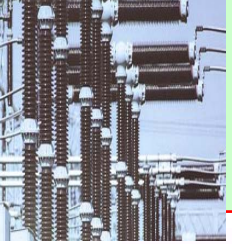
voltage distribution
Old survey



voltage distribution 2004
New survey



Voltage distribution

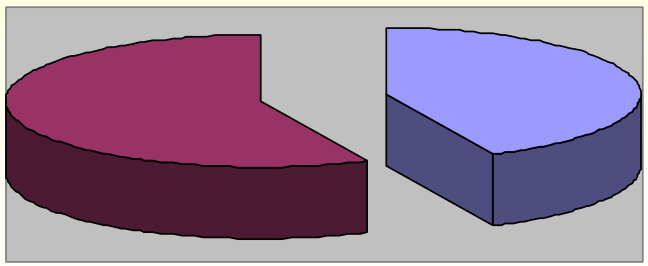


CIGRE WG A3.06 Reliability of High Voltage Equipment
Preliminary results
CIRCUIT BREAKERS

Population data

type of enclosure old survey

Non metal enclosed 57%

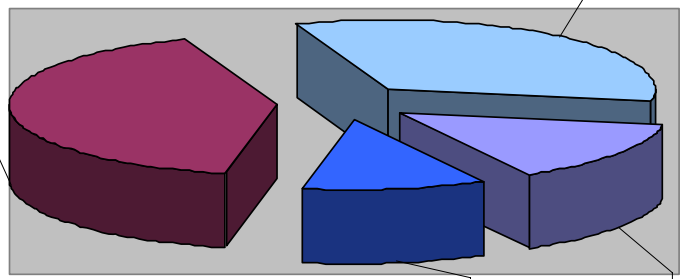


Metal enclosed 43%

type of enclosure 2004 new survey

Live tank 42%

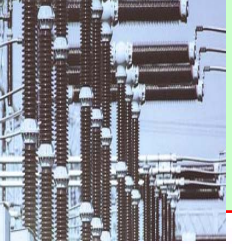
Dead tank 33%



GIS - 3 phase 11%

GIS - 1 phase 14%

Type of enclosure



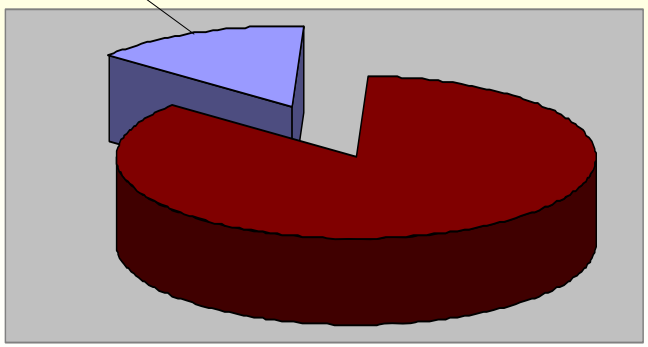
CIGRE WG A3.06 Reliability of High Voltage Equipment
Preliminary results
CIRCUIT BREAKERS

Population data

location
old survey

Indoors
15%

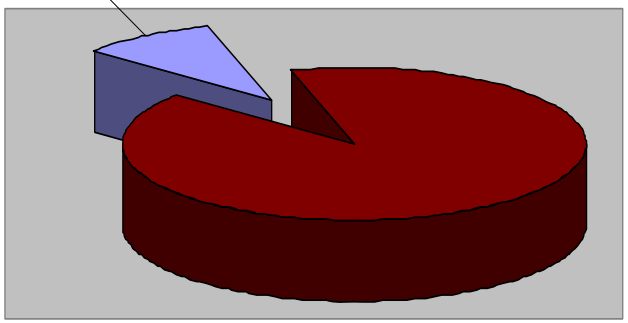
Outdoors
85%



location 2004
new survey

Indoor
10%

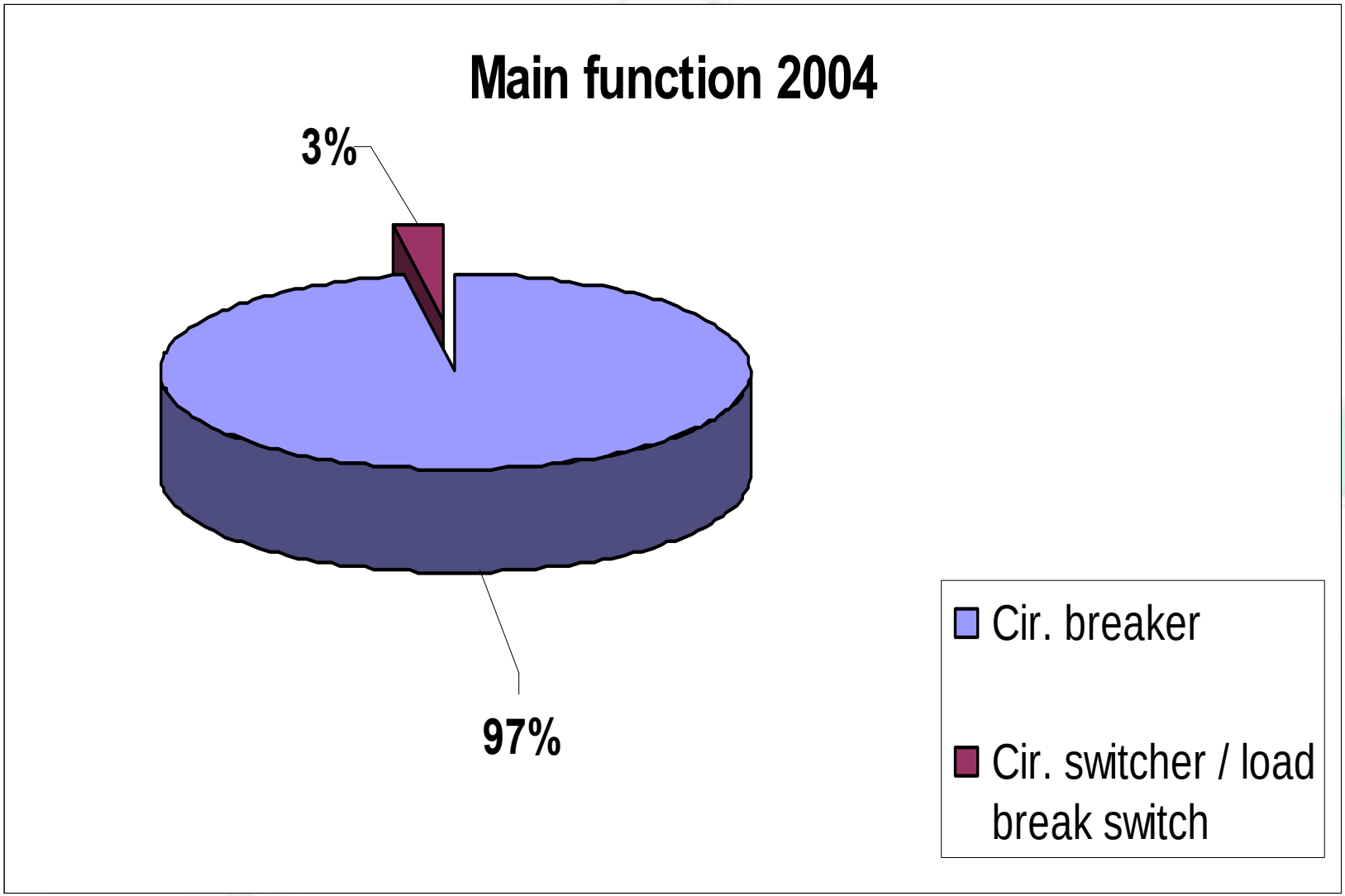
Outdoor
90%



Location

CIRCUIT BREAKERS

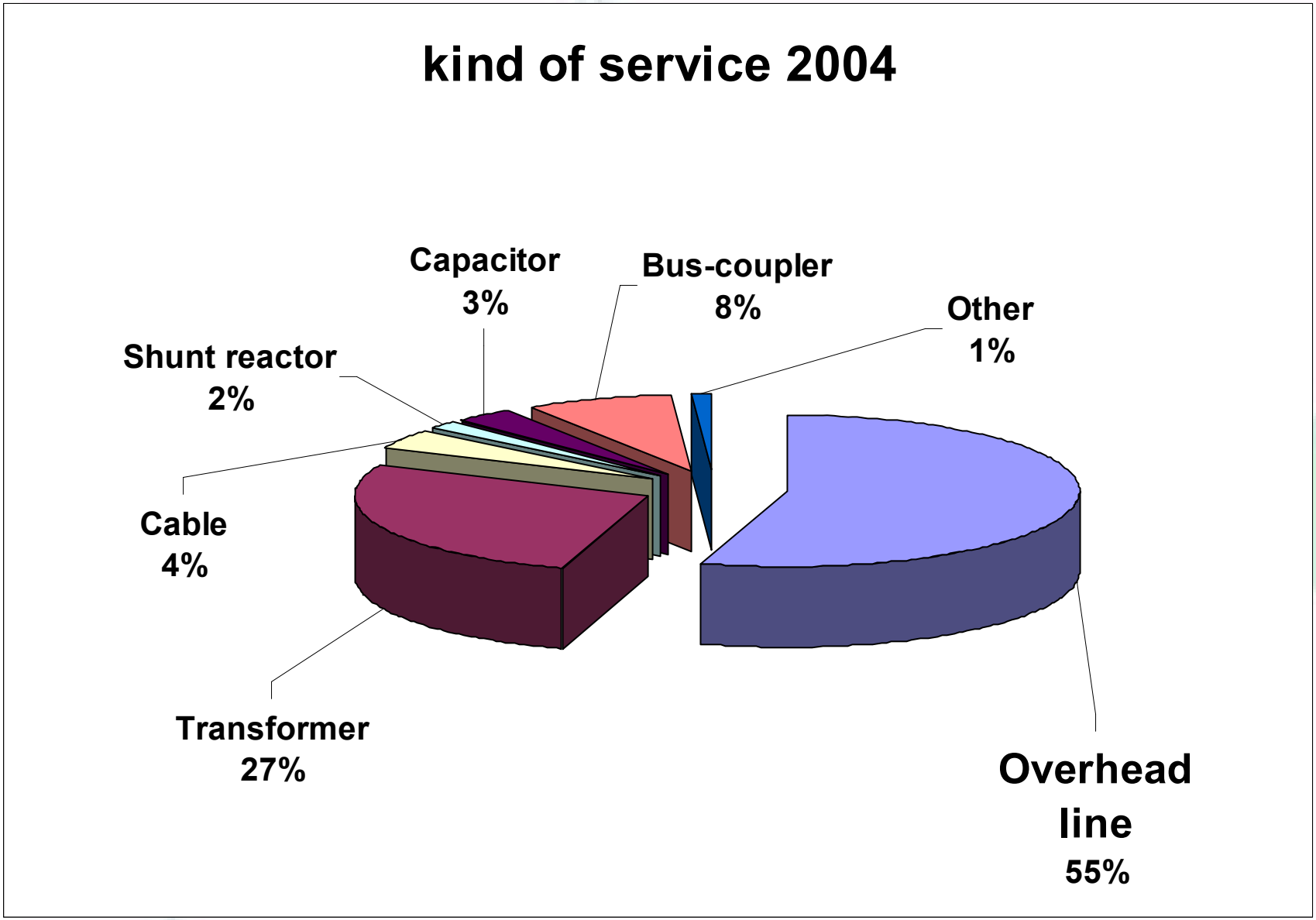
Population data



Main function

CIRCUIT BREAKERS

Population data

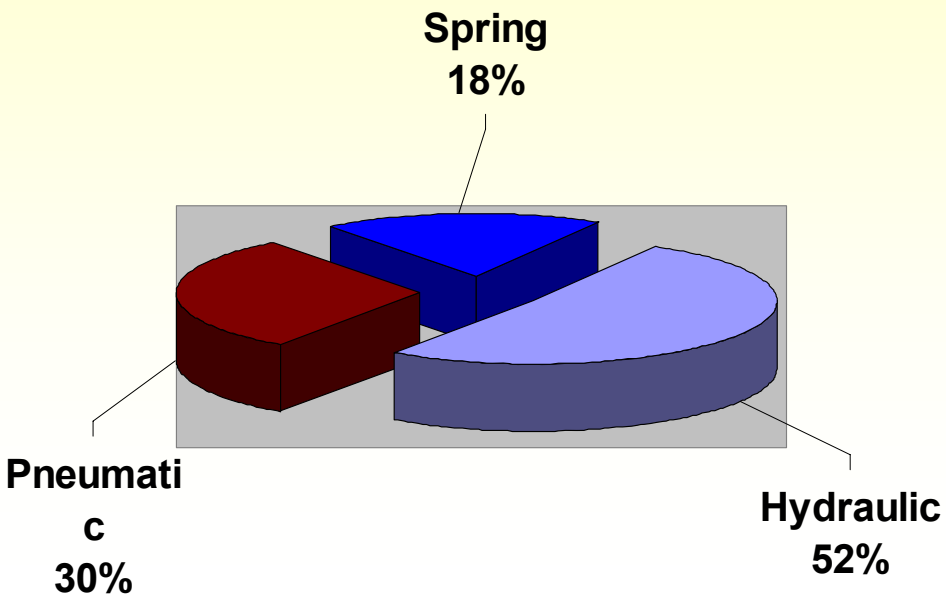


Kind of service

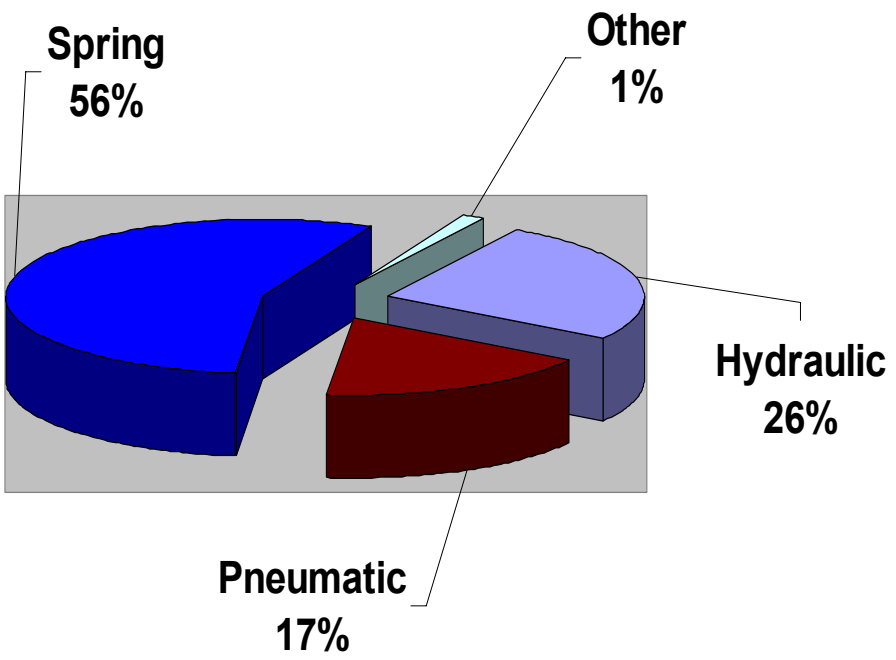
CIRCUIT BREAKERS

Population data

type of operating mechanism old survey



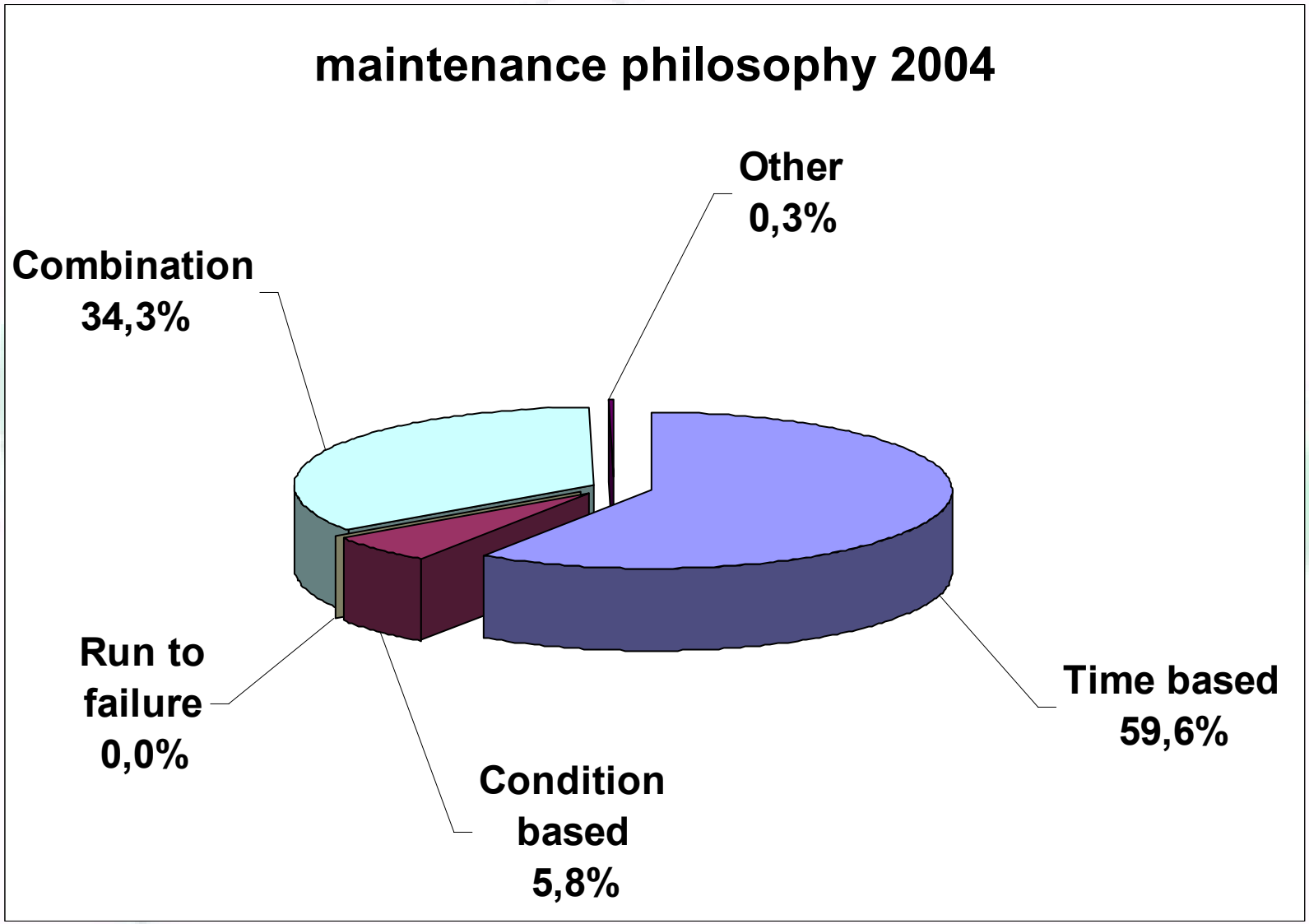
type of operating mechanism 2004 new survey



Type of operating mechanism

CIRCUIT BREAKERS

Population data



Maintenance philosophy

Failure Distribution

CIRCUIT BREAKERS

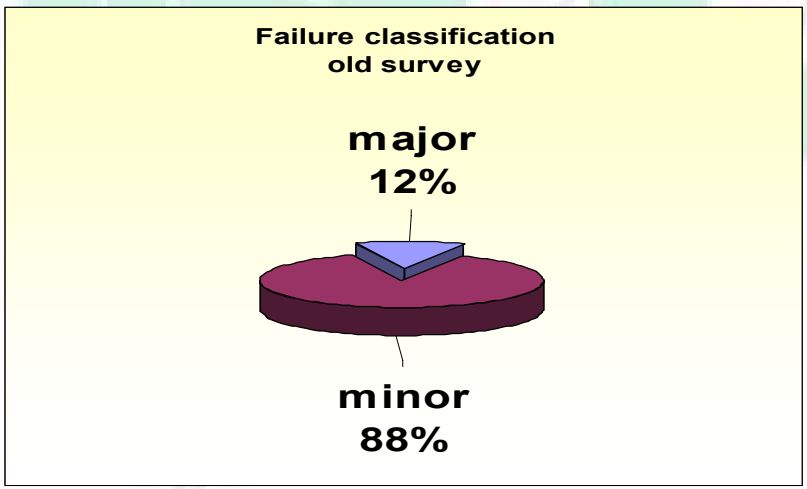
Failure data

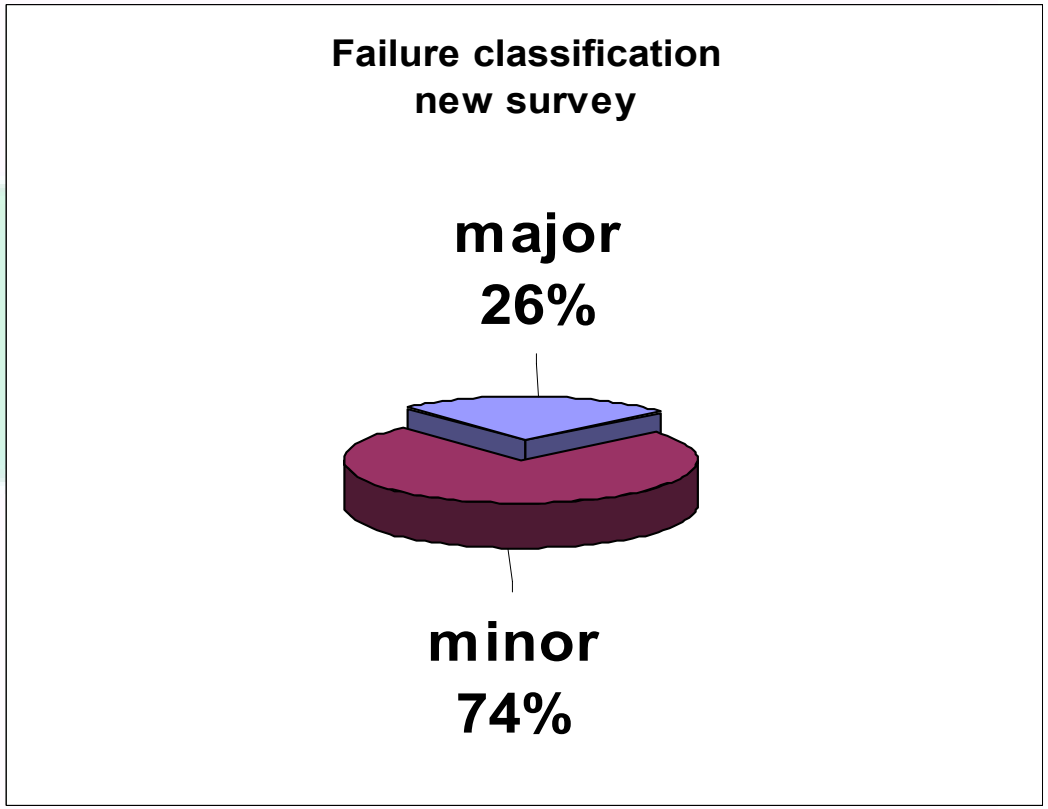
Old Survey
1988-91

Minor: 3358

Major: 475

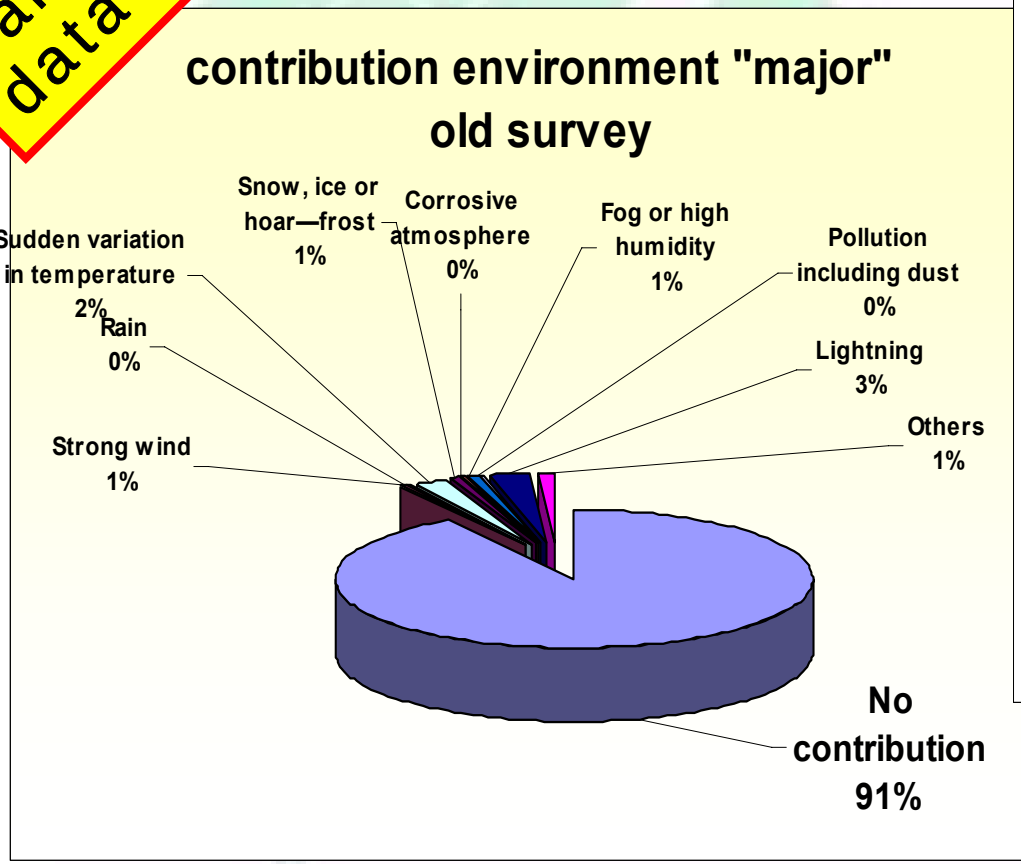
New Survey
up to 2005

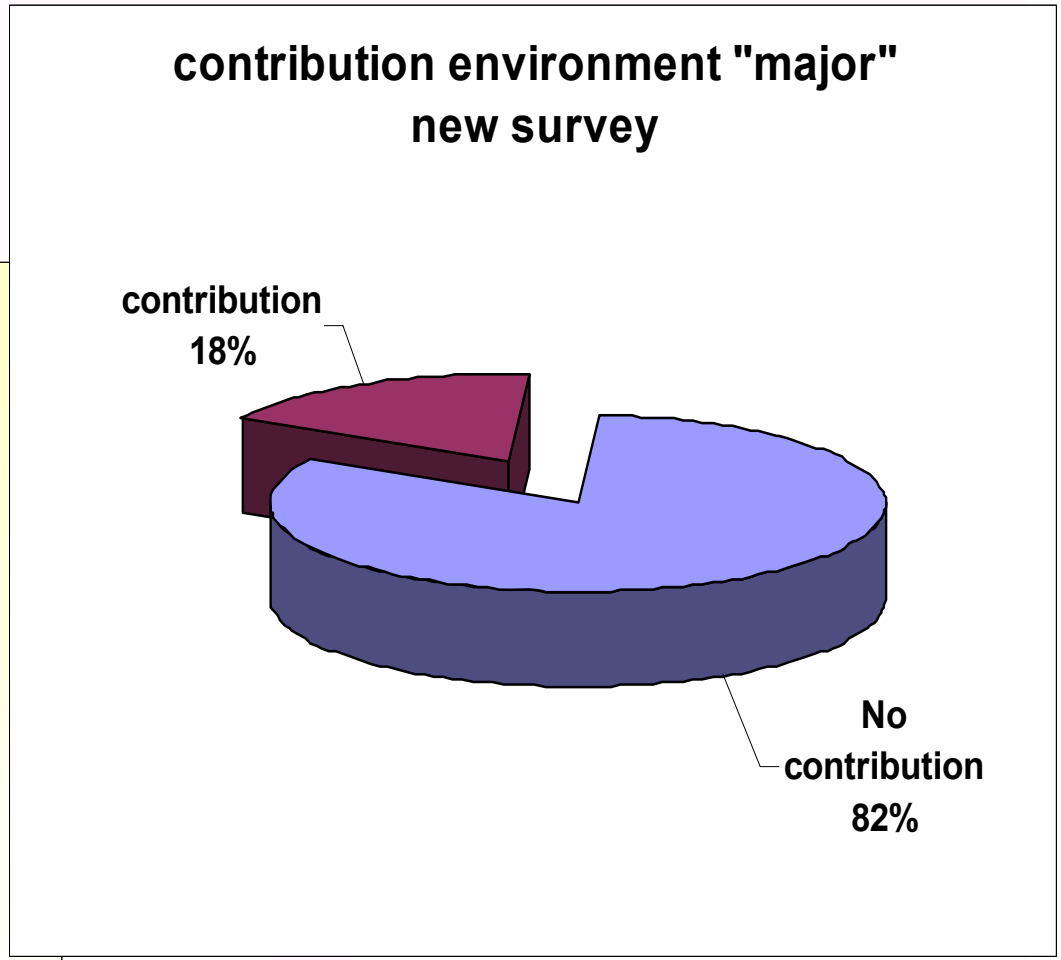




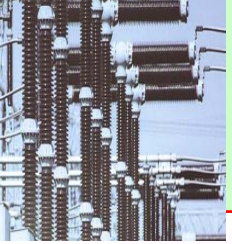
Failure classification

Failure data



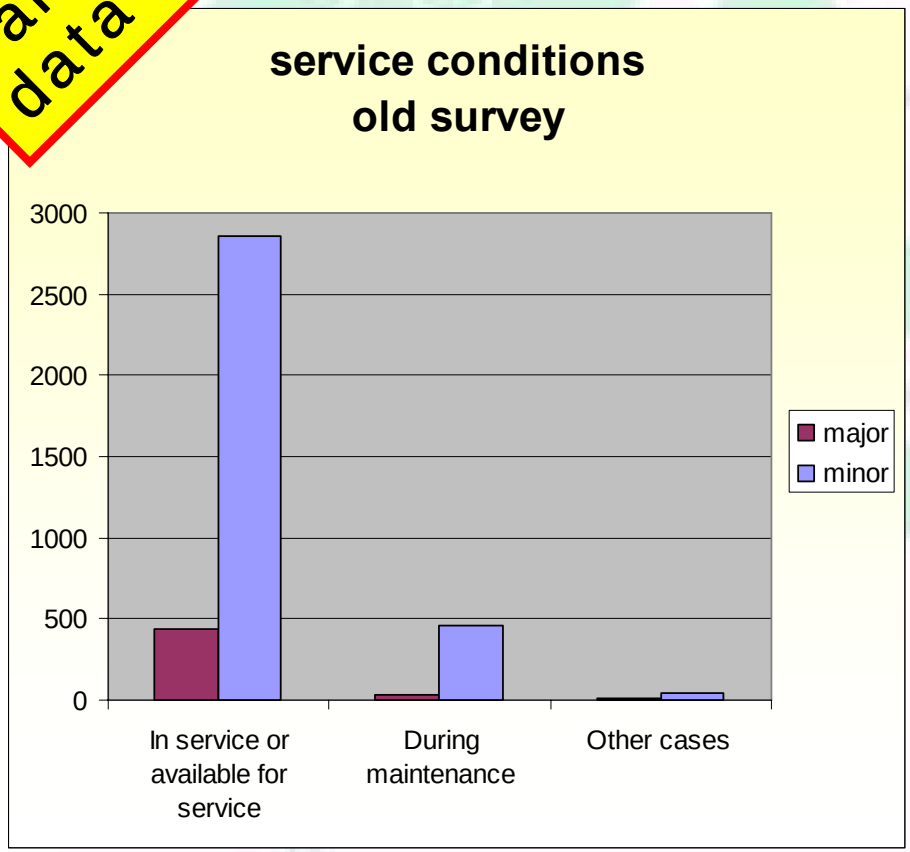


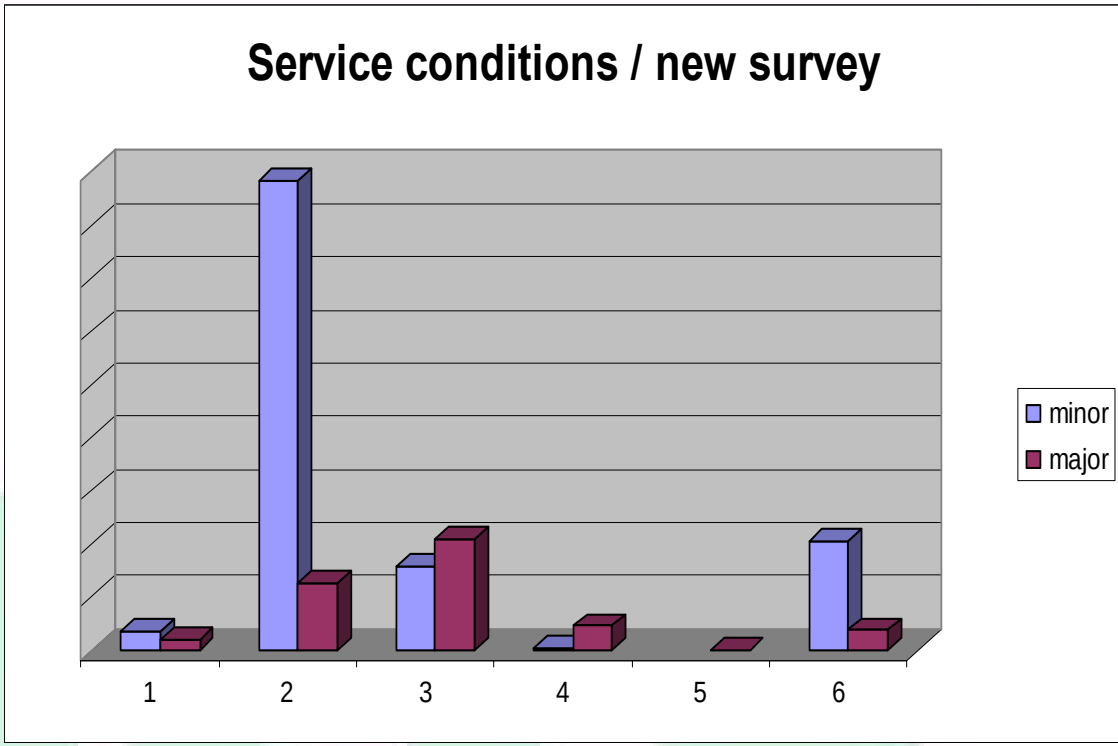
Contribution of environment



CIGRE WG A3.06 Reliability of High Voltage Equipment
Preliminary results
CIRCUIT BREAKERS

Failure data





1 de-energized - Available for service

2 Normal service - no operation command

3 Normal service operation demanded

4 Fault clearing operation

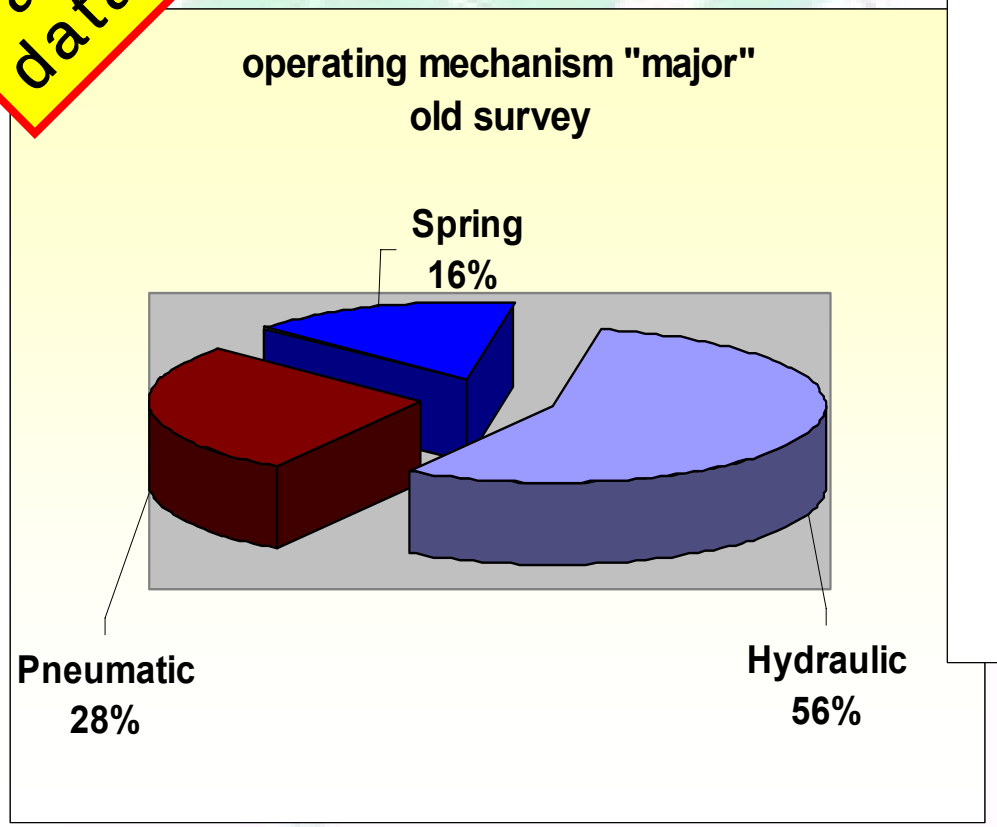
5 Operation occurred without command

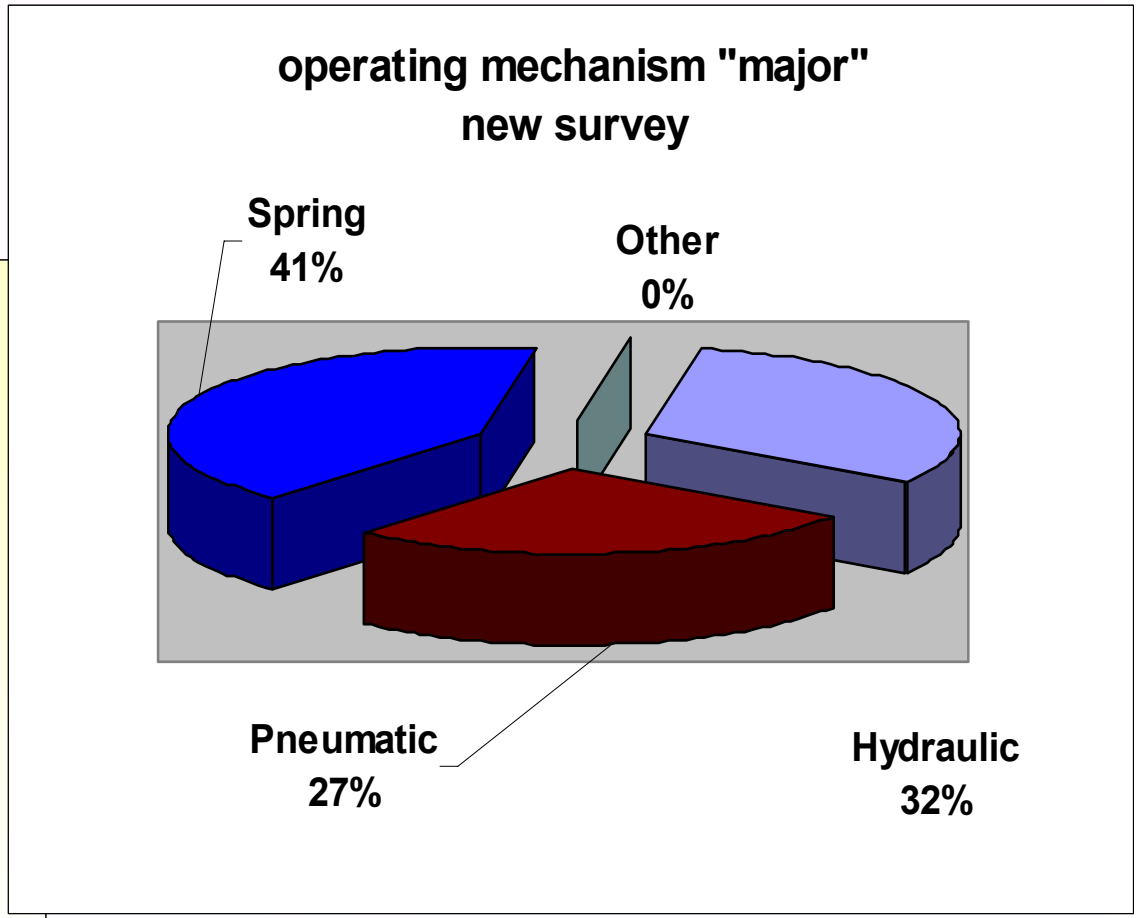
6 During or directly after testing / maintenance

Service conditions

CIRCUIT BREAKERS

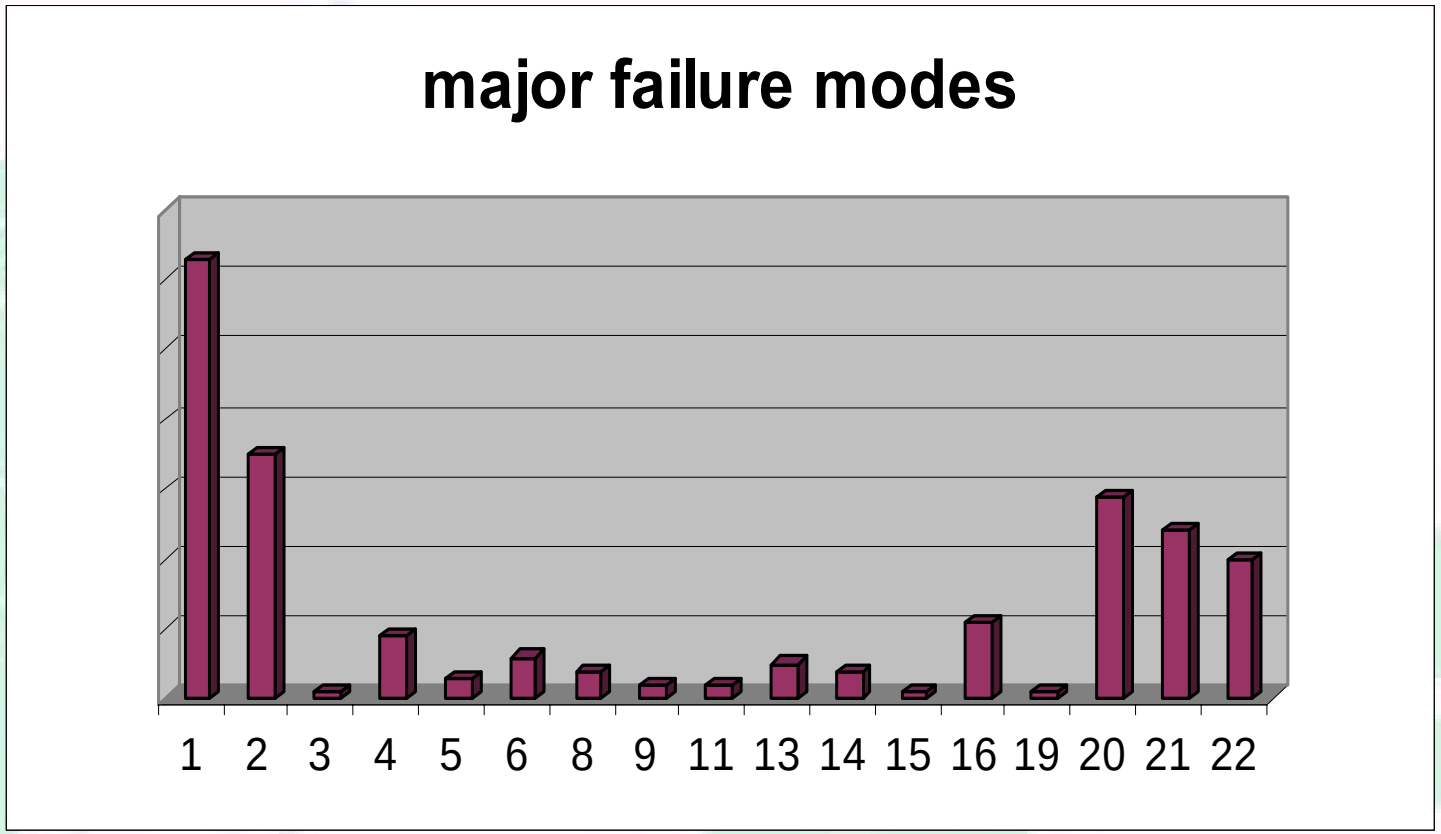
Failure data





Type of operating mechanism

Failure data



Main failure modes:

1+2 Does not close / open on command

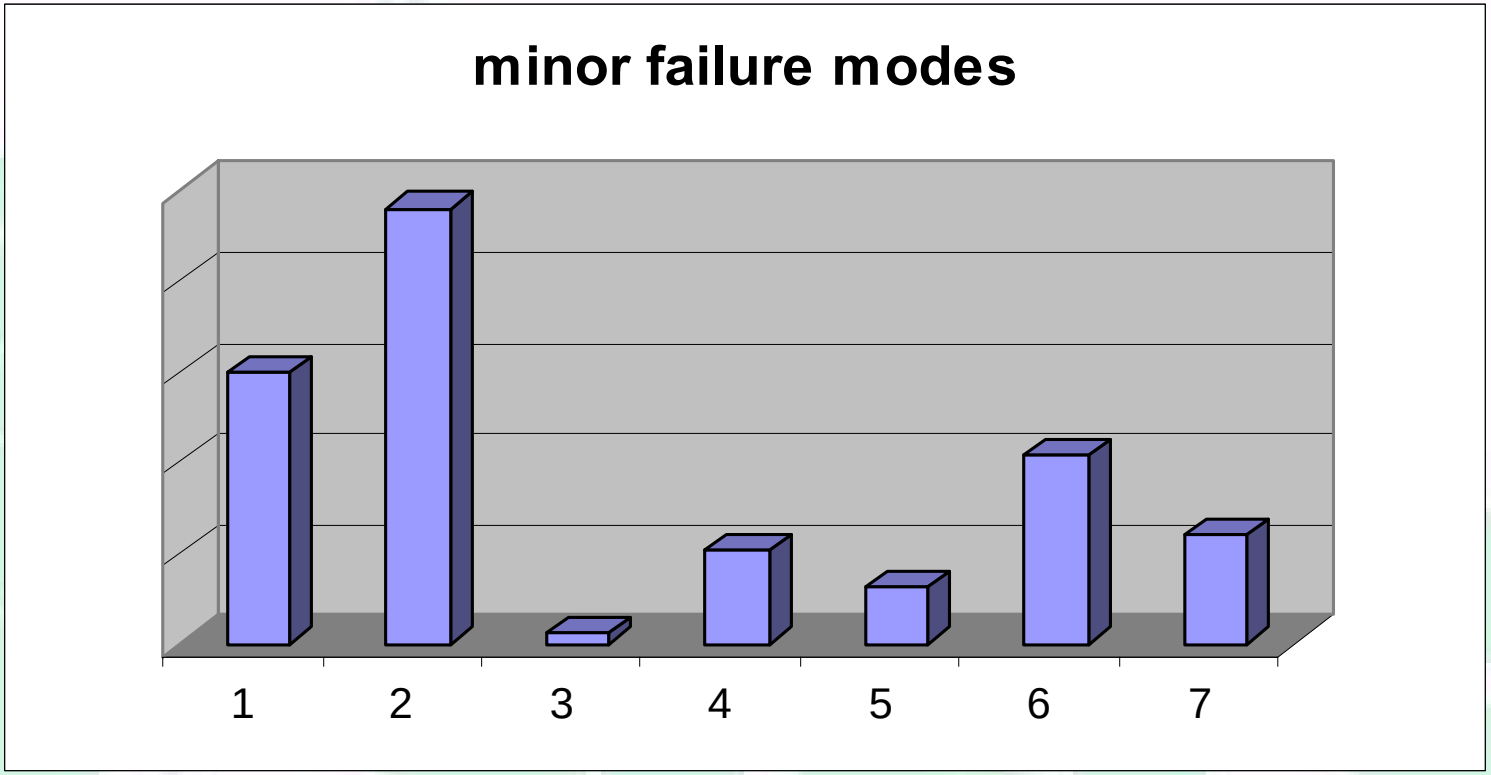
20 Locking in open or closed position by the control system

21 Loss of mechanical integrity

Major failure modes

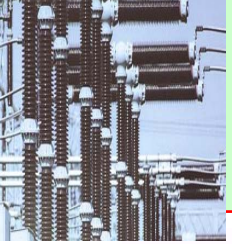
CIRCUIT BREAKERS

Failure data



1 **Air or hydraulic oil leakage in the operating mechanism**
2 **Small SF6 leakage**
3 Oil leakage of grading capacitors
4 Change in mechanical functional characteristics
5 Change in electrical functional characteristics
6 **Change in functional characteristics of control or auxiliary systems**
7 **Other**

Minor failure modes



CIRCUIT BREAKERS

Failure data

Population data

- The majority of the CB´s is used at service voltages between 60 and 200 kV
- The majority is still of non metal enclosed design and installed outdoors
- 55% of the CB´s are used for overhead line switching
- The mainly used type of operating mechanism has changed from hydraulic to spring design
- Most of the failures seem to happen during normal service
- Leakage of SF6 or oil seems still to be a problem

Main Conclusions

Muito obrigado por sua atenção !

High Voltage

CIGRE WG A3.06
Preliminary Results
Circuit Breakers

WG A3-06 Tutorial
June 2006
Rio de Janeiro

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